How can plastic and reconstructive surgery reach Net Zero as a specialty?

Plastic and reconstructive surgery can transform an individual's life. However, given by name and nature, the speciality may sound formidable in reaching the Net Zero goal, a balance between greenhouse gas emission and removal, because of excessive single-use material and energy usage. Working at the National Health Service (NHS) may not convince you of the ambition towards a carbon-free goal with the filled orange bin and computers being switched on at all-time in a warm theatre amid energy crises. Following the landmark legislation of the Climate Change Act 2008 and Health and Care Act 2022, the ethos of Net Zero embeds in the legislation and healthcare system. The official objective is to reach a Net Zero NHS carbon footprint by 2040 (1). This essay intends to explore strategies to reach the Net Zero from the pre-operative, operative and post-operative points of view in plastic and reconstructive surgery and conclude with an overall plan in addressing the grand challenge of the century.

Before Entering Operation Theatre: Pre-operative

Road travel makes up 14% of emissions at the NHS (1). Electrifying the fleet and staff vehicles would help, but at a significant cost. An immediate solution would be the Car Share scheme, which is implemented at Nottingham University Hospitals NHS Trust and provides a platform to share rides and curb congestion and pollution (2). The North Manchester General Hospital constructed secure cycle storage space and changing facilities as part of the sustainable travel plan, encouraging cycling to work and changes in habitual commuting practice (3).

The lockdown policy during COVID-19 sheds light on how the virtual outpatient clinic can run with minimal reduction in the quality of service. A survey revealed that 71% and 98% of senior plastic surgeons reported no concerns about personal safety and the likely use of virtual consultation after lockdown respectively (4). The Royal College of Surgeons, in adjunct with the British Association of Plastics, Reconstructive and Aesthetics Surgery (BAPRAS), can issue guidelines eliciting which procedures can be consented to virtually or must be seen in person. The harness of virtual consultations is financially efficient and lessens the need for patients, staffs, and surgeons to commute daily, furthering the effort to reaching Net Zero.

Anaesthetic and analgesic practices contribute 2% of the NHS carbon footprint (5). The Royal College of Anaesthetists has been committed to decommissioning desflurane by early 2024 to prioritise clinically safe and eco-friendly alternatives. The general approach is to restrict the use of anaesthetic gas to a finite amount of surgery for which there is no alternative. For instance, some foreign body removal surgeries might not be too complicated, and it might be possible to commence the surgery with a regional block, while general anaesthesia may remain an option during surgery if necessary. Local anaesthetic is always preferred thanks to shorter procedure time and inpatient stays, considering that each hospital bed consumes 29,199 kWh annually (6). In the case of hand surgery, the Wide-awake Local Anesthesia No Tourniquet (WALNUT) procedure has become increasingly popular since it presents with faster recovery, and much fewer anaesthetic side effects and carbon footprints.

Entering the Operation Theatre: Intra-operative

It is alarming that medical equipment and other supply chain share 34% of NHS's carbon footprint, which led us to reflect on which equipment and supplies may be unnecessary. A better solution to the longstanding issue of plastic and reconstructive surgery is the use of reusable theatre standard gowns, which is happening in the University Hospitals Birmingham NHS Foundation Trust (7). Field sterility, defined as preparing the surgery site with iodine or chlorhexidine, sterile gloves, and masks but not gown, cap, and prophylactic antibiotics, resulted in a superficial infection rate of 0.4% and a deep infection rate of 0% following carpal tunnel surgery (8,9). In other words, some surgical gowns and supplies may possess limited marginal benefit in the outcome of plastic surgery from an infection control point of view. The general guiding principle of waste reduction is highlighted in the 5 'R's: Reducing waste, Reusing materials; Recycling; Rethinking waste disposal; and Research (10). Forward-thinking and accurate predictions are equally paramount when wasted items amounted to over 441kg of carbon dioxide during the study period of 85 consecutive cases at a hand surgery operating room (11).

Biomaterials, defined as synthetic polymers acting as carriers for scaffolds for tissue regeneration (12), are promising fields but with limited hitherto large-scale implementation in plastic surgery. For instance, a biodegradable temporising matrix can shorten inpatient hospital stays and lower morbidity reducing surgical risks and potential carbon footprint (13,14), in addition to improved contour and pliability. The development and application of 3D manufacturing technology unveil a new arena for plastic surgery. Alongside imaging technologies, a tailored implant can be manufactured swiftly on-site at the hospital to fit into a craniomaxillofacial reconstruction, skin manufacturing and breast reconstruction surgery (15), reducing the need to come to the hospital twice for a new implant.

Surgical trainees occasionally require support from senior consultants. On encountering complex and unseen cases, immediate input from a senior member will save a life. Those days, the consultant may have to fully scrub in with a single-use gown. The world's first robotic surgery using 5G communication technology demonstrated how senior surgeons can obtain first-hand visual information and provide feedback and assistance on the spot, thanks to the extremely low latency and high reliability (16). Ultra-remote clinical surgery is already proven to be safe and smooth in radical cystectomy (17). Surgery has the potential to be performed in any district hospital or rural clinic since the plastic surgeon can remotely control the robotic arm in a distant hospital. To date, the application of next-generation telecommunication and robotics in plastic and reconstructive surgery has received scant attention in the NHS, which leads to some polysynthetic fabric wastage and unnecessary commuting from local hospital to tertiary centre.

The maintenance of the theatre environment could be energy costly. In rhinoplasty, the building energy in the theatre and recovery room would leave 7.22 and 1.12 kg of carbon footprint respectively (18). It would be even higher for abdominoplasty resulting in 12.54 kg of carbon footprint in building energy (18). Given that the operation theatre is vacant 40% of the time (10), lowering the room temperature and switching off idle computers, lights, and running machines are feasible suggestions. The Oregon Health and Science University

Hospital refitted light-emitting diode lights and low-mercury lamps and has saved 340,000 kWh annually since 2004 (19). A traditional 3-minute scrub for a Dupuytren's Contracture surgery may require three personnel and over 55 litres of clean water (20). Aseptic, waterless, and alcohol-based technique may boost environmental conservation efforts (21). The silver lining of the ongoing energy crisis propels the reflection and optimisation of current energy use for every NHS stakeholder, including plastic surgeons.

Leaving the Operation Theatre: Post-operative

Resources reduction requires multi-disciplinary input in a plastic surgery department, including nurses and administration staff. The patient-centred procurement system for wound care enables better use of resources by limiting over-ordering and associated risks of dressing (22). The post-surgical dressing should be as simple as possible and synthetic polymeric biomaterials should be prioritised. Synthetic polymeric biomaterials can be manufactured based on plant-based cellulose (23), curbing the demand for petroleum-based plastics (24). Nonetheless, not all synthetic polymeric biomaterials are completely eco-friendly but still require much energy to produce and hence minimal dressing should be the first point of call.

Plastic surgeons in local hospital can enhance patient safety, decrease their environmental impact, and stimulate research and innovation by learning from other surgical specialties or external hospitals. The surgical team should reflect on the use of the equipment and report key figures in internal audit meetings. Research grant bodies may consider eco-friendliness on processing application. Additionally, system engineering can help identify and propose improvements, and closer collaboration with the biosynthetic industry may help eliminate obsolete petroleum-based plastics. Effective top-down leadership is essential to drive changes.

Most practices and changes have been done locally in an NHS trust. In plastic surgery, surgeons can utilise the connections of national professional bodies, such as BAPRAS and the Plastic Surgery Trainees Association. It can raise awareness of the eco-friendly practice and encourage multi-centre trials to examine the effectiveness and safety of a novel clinical technique, laying the fundamentals for nationwide adoption. Moreover, national and international professional bodies should lead by example and convert carbon-neutral medical conferences to a norm (25), formulating pioneering transformation in academic plastic surgery event management.

Conclusion

Though Net Zero has become an all-embracing ambition, it has yet to receive significant attention in plastic and reconstructive surgery. Hospitals and surgeons should continually educate themselves and build upon the achievements of eco-friendly practices. Exploring and learning the success of practices in other surgical specialties can inspire some advances. Plastic and reconstructive surgery is a captivating and specialized discipline that combines knowledge and skills, and importantly the creativity to address the issue of carbon footprint

while also exploring ways to contribute to Net Zero as both a speciality and a sustainable environment for generations to come.

(1500 words)

Reference

1. NHS England. Delivering a 'Net Zero' National Health Service. London; 2022 Jul.
2. NUH. NUH Car Share scheme [Internet]. Nottingham University Hospitals. 2023 [cited 2023 Feb 24]. Available from: https://www.nuh.nhs.uk/nuh-car-share-scheme/
3. MFT. Multi-Storey Car Park and Cycle Hub [Internet]. Manchester University NHS Foundation Trust. 2023 [cited 2023 Feb 24]. Available from: https://mft.nhs.uk/transforming-the-future-at-north-manchester-general-hospital/follow-our-progress/multi-storey-car-park-and-cycle-hub/
4. Sinha V, Malik M, Nugent N, Drake P, Cavale N. The Role of Virtual Consultations in Plastic Surgery During COVID-19 Lockdown. Aesthetic Plast Surg. 2021 Apr 31;45(2):777–83.
5. Watts N, Moonesinghe R, Foreman C. Putting anaesthetic emissions to bed: commitment on desflurane [Internet]. NHS England. 2023 [cited 2023 Feb 24]. Available from: https://www.england.nhs.uk/blog/putting-anaesthetic-emissions-to-bed/
6. ETKHO. Current outlook of hospital energy cost and consumption [Internet]. ETHKO Hospital Engineering. 2021 [cited 2023 Feb 26]. Available from: https://www.etkho.com/en/current-outlook-of-hospital-energy-cost-and-consumption/
7. UHB. Coronavirus staff guidance - Gowns [Internet]. University Hospitals Birmingham NHS Foundation Trust. 2021 [cited 2023 Feb 25]. Available from: https://www.uhb.nhs.uk/coronavirus-staff/gowns.htm
8. LeBlanc MR, Lalonde DH, Thoma A, Bell M, Wells N, Allen M, et al. Is Main Operating Room Sterility Really Necessary in Carpal Tunnel Surgery? A Multicenter Prospective Study of Minor Procedure Room Field Sterility Surgery. HAND. 2011 Mar 18;6(1):60–3.
9. Yu J, Ji TA, Craig M, McKee D, Lalonde DH. Evidence-based Sterility. Plast Reconstr Surg Glob Open. 2019 Nov;7(11):e2481.
10. Kagoma Y, Stall N, Rubinstein E, Naudie D. People, planet and profits: the case for greening operating rooms. Can Med Assoc J. 2012 Nov 20;184(17):1905–11.
11. Bravo D, Thiel C, Bello R, Moses A, Paksima N, Melamed E. What a Waste! The Impact of Unused Surgical Supplies in Hand Surgery and How We Can Improve. HAND. 2022 Apr 29;155894472210840.
12. Yuan Z, Nie H, Wang S, Lee CH, Li A, Fu SY, et al. Biomaterial Selection for Tooth Regeneration. Tissue Eng Part B Rev. 2011 Oct;17(5):373–88.
13. Li H, Lim P, Stanley E, Lee G, Lin S, Neoh D, et al. Experience with <scp>NovoSorb</scp> ® Biodegradable Temporising Matrix in reconstruction of complex wounds. ANZ J Surg. 2021 Sep 3;91(9):1744–50.

14. Shah R, Kiely A, McKirdy S. Double-layer biodegradable temporising matrix reconstruction for abdominal skin and soft-tissue reconstruction. BMJ Case Rep. 2022 Nov 11;15(11):e251848.
15. Peng W, Peng Z, Tang P, Sun H, Lei H, Li Z, et al. Review of Plastic Surgery Biomaterials and Current Progress in Their 3D Manufacturing Technology. Materials. 2020 Sep 16;13(18):4108.
16. Huawei. World's First Remote Operation Using 5G Surgery [Internet]. Huawei Technologies Co., Ltd. 2019 [cited 2023 Feb 25]. Available from: https://www.huawei.com/uk/huaweitech/industry-insights/outlook/mobile-broadband/wireless-for-sustainability/cases/worlds-first-remote-operation-using-5g-surgery
17. Yang X, Wang Y, Jiao W, Li J, Wang B, He L, et al. Application of 5G technology to conduct tele-surgical robot-assisted laparoscopic radical cystectomy. The International Journal of Medical Robotics and Computer Assisted Surgery. 2022 Aug 4;18(4).
18. Berner JE, Gras M del P, Troisi L, Chapman T, Vidal P. Measuring the carbon footprint of plastic surgery: A preliminary experience in a Chilean teaching hospital. Journal of Plastic, Reconstructive & Aesthetic Surgery. 2017 Dec;70(12):1777–9.
19. Laustsen G. Greening in healthcare. Nurs Manage. 2010 Nov;41(11):26–31.
20. Jehle K, Jarrett N, Matthews S. Clean and Green: Saving Water in the Operating Theatre. The Annals of The Royal College of Surgeons of England. 2008 Jan;90(1):22–4.
21. Javitt MJ, Grossman A, Grajewski A, Javitt JC. Association Between Eliminating Water From Surgical Hand Antisepsis at a Large Ophthalmic Surgical Hospital and Cost. JAMA Ophthalmol. 2020 Apr 1;138(4):382.
22. NHS England. The Atlas of Shared Learning - Procuring for effective wound management [Internet]. NHS England. 2018 [cited 2023 Feb 26]. Available from: https://www.england.nhs.uk/atlas_case_study/procuring-for-effective-wound-management/
23. Gandini A, M. Lacerda T. Monomers and Macromolecular Materials from Renewable Resources: State of the Art and Perspectives. Molecules. 2021 Dec 28;27(1):159.
24. Amarakoon M, Alenezi H, Homer-Vanniasinkam S, Edirisinghe M. Environmental Impact of Polymer Fiber Manufacture. Macromol Mater Eng. 2022 Nov 26;307(11):2200356.
25. Zotova O, Pétrin-Desrosiers C, Gopfert A, van Hove M. Carbon-neutral medical conferences should be the norm. Lancet Planet Health. 2020 Feb;4(2):e48–50.